OPERATION & MAINTENANCE

of the

TWO-TEMPERATURE Military HemaCool™

A Field Rugged, Advanced Technology Refrigerator/Freezer

For

Blood, Blood Products & Medical Supplies

Model HMC-MIL-1

ENERGY STORAGE TECHNOLOGIES, INC.

7610 McEwen Road

Dayton, Ohio 45459 U.S.A.

www.estglobal.com

support@estglobal.com

Telephone: (937) 312-0114

Fax: (937) 312-1277

August 2003

This manual is solely for the HemaCool™ HMC-MIL-1. It provides a set of instructions for the unpacking, operating, data logging and routine maintenance of the unit.

For assistance with this unit – or any Energy Storage Technologies product -- email **support@estglobal.com** or telephone 937-312-0114 and ask for technical support.

CAUTIONS:

- **USE THE COOL (+4.0±1.5°C [39.2° ±2.7°F]) TEMPERATURE SETTING ONLY WITH MATERIALS THAT MUST BE STORED ABOVE FREEZING.**

  USE THE FREEZE (–22+0/–6°C [–7.6+0/–11°F]) TEMPERATURE SETTING ONLY FOR MATERIALS THAT MUST BE STORED FROZEN.

- **THE TEMPERATURE SETTING TOGGLE SWITCH IS A LOCKING TYPE SWITCH, AND YOU MUST PULL OUT ON THE HANDLE TO CHANGE IT. DO NOT FORCE!**

- **IF UNIT IS STORED INVERTED OR ON ITS SIDE, ALLOW IT TO SIT UPRIGHT AT LEAST TWO HOURS BEFORE OPERATING IT.**

- **DO NOT TILT THE UNIT OVER 30° WHILE OPERATING.**

- **FOR MAXIMUM EFFICIENCY DO NOT TILT AT ALL DURING OPERATION.**

- **DO NOT STORE THE UNIT IN AMBIENT TEMPERATURES BELOW -30°C (-22°F) OR OVER 65°C (149°F).**

- **DO NOT OPERATE THE UNIT IN THE REFRIGERATOR MODE IN AMBIENT TEMPERATURES BELOW -20°C (-4°F) OR ABOVE 49°C (120°F).**

- **DO NOT SIT OR STAND ON THE UNIT.**

- **DO NOT TRANSPORT UNIT WITHOUT THE OUTER LID IN PLACE AND ALL INNER LID AND OUTER LID LATCHES CLOSED.**

- **HEMACOOL UNITS MAY BE SAFELY STACKED TWO UNITS HIGH.**

- **DO NOT SUBMERGE THE UNIT IN WATER.**

TABLE OF CONTENTS

Subject	Page
A. Unit Overview	4
B. Unpacking and Readying for Operation	6
C. Starting the **HemaCool™**	10
D. The **HemaCool™** Display and Alarm Functions	14
E. Data Logger and Pocket PC Download	17
F. **HemaCool™** Maintenance	20
G. **HemaCool™** Specifications	29
H. Warranty	30
Appendix A – PCM Wall Option	31
Appendix B – Tools and Parts	33

If the user has questions about the unit, he/she should contact Energy Storage Technologies, Inc., by phone at 937-312-0114; by fax at 937-312-1277; or by email at support@estglobal.com.

Fig. 1. Mil version **HemaCool™** side and control end

A. UNIT OVERVIEW:

The HemaCool™ is designed to preserve liquid or frozen blood products and medical supplies. HemaCool™ provides exceptional field storage through its combination of superior insulation technology and temperature controls based on microcontroller solid-state electronics.

The **HemaCool™** is portable and self-powered, utilizing internal gel cell batteries. The system will accept electrical power from multiple sources, e.g. 12-24VDC from batteries or other sources at the AUX input, solar panels, or a wide range of grid power standards (any combination of 90–264 VAC and 47–63 Hz line frequencies). The unit is designed with solar panel lightning protection.

If the unit is fully stocked – and no power is applied [unit off] – it will take more than two hours for the internal payload temperature to rise to 6°C (43°F) in an ambient temperature of 49°C (120°F). With the optional thermal barrier in place, the unit is also capable of chilling five (5) units of freshly transfused blood to 6°C (43°F) within eight (8) hours.

The HemaCool™ will perform in either COOL or FREEZE mode.

- In COOL mode (+4.0°) the unit -- provided its two internal 20 amp-hour batteries are properly charged -- will maintain a temperature range of 1°C to 6°C (34°F to 43°F) for more than 24 hours, at +24°C ambient temperature (75°F).

- In FREEZE mode (-22°) the unit – provided its two internal 20 amp-hour batteries are properly charged – will keep blood products frozen for more than eight hours, at an ambient temperature of +24°C (75°F). (This colder operation does, however, reduce the battery-powered hold time. See specifications at the end of this document.)

For additional payload security, the **HemaCool™** is also equipped with an internal heater that will prevent refrigerated payload from freezing if the unit is in an environment that is below 1°C (34°F), but no lower than –20°C (-4°F).

NOTE: The standard default temperature scale setting for the **HemaCool™** is Celsius (°C). The unit may be special ordered to display temperature in the Fahrenheit (°F) scale.

B. UNPACKING AND READYING THE HemaCool™ FOR OPERATION:

Remove the **HemaCool™** from its crating materials. Unlatch the outer lid. This lid has 10 latches, one on each end and four on each side. Flip out and rotate the key tabs on each latch until each latch claw has released its hasp.

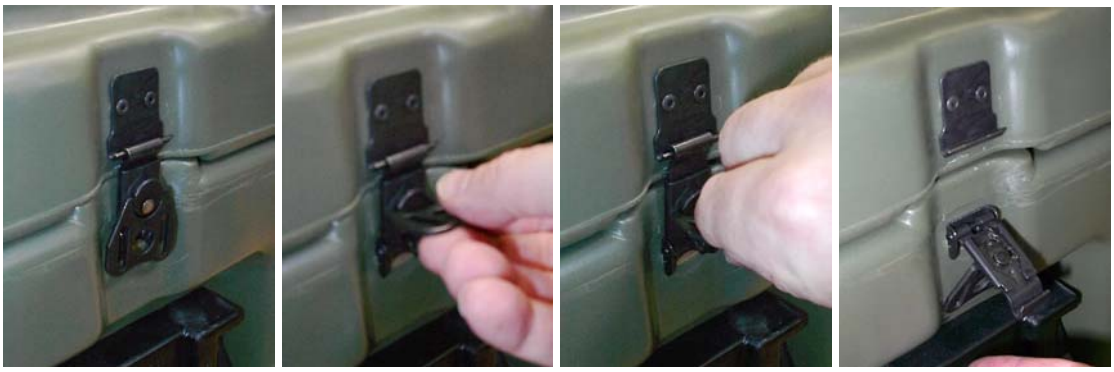

Fig. 2. To unlatch the outer lid: flip up latch tab and rotate ½ turn left. Drop open.

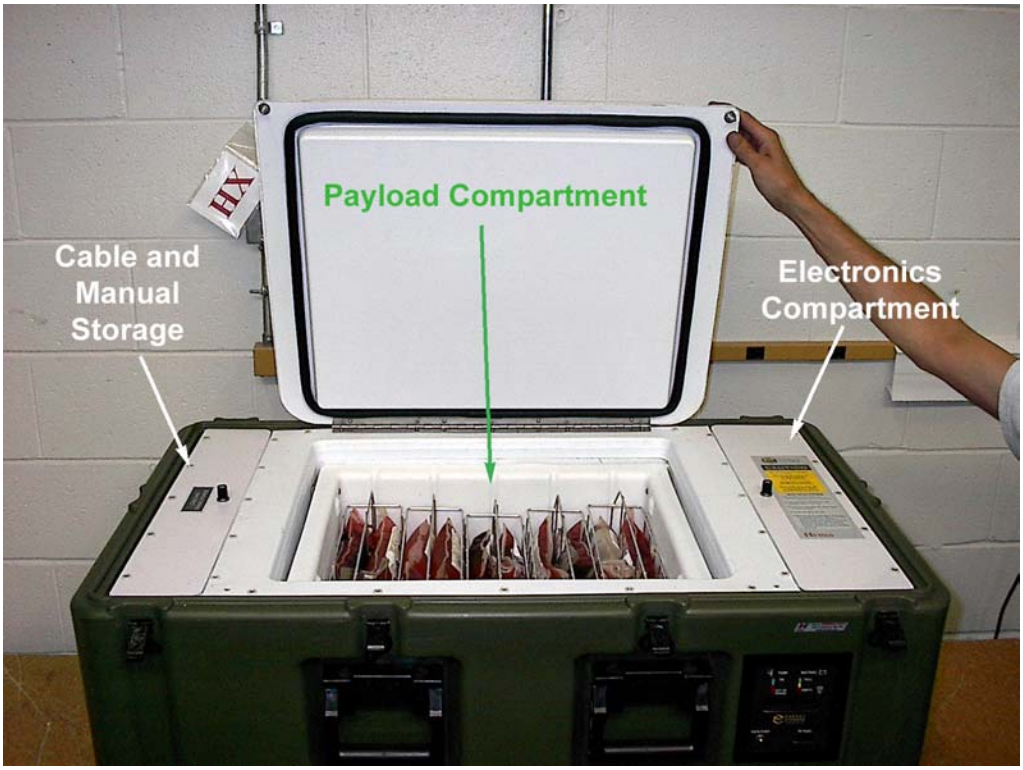

Fig. 3. Under the exterior lid the **HemaCool™** is divided into three compartments.

The **HemaCool™** is shipped with its internal batteries disconnected. Before initial use the batteries must be connected. To do this:

1. Open the compartment lid labeled “Cable And Manual Storage” (upper half of **Fig. 4**).

2. Remove the contents (lower half of **Fig. 4**).
3. Use the supplied screwdriver (or any #2 Phillips head screwdriver) to remove the four corner screws that hold the compartment liner in place (**Fig. 5**).
4. Lift out the compartment liner (**Fig. 6**).
5. Inside are two sets of connectors. The square pair is already plugged in. The flat pair connects the batteries. Plug the flat pair into each other (**Fig. 7**).
6. Replace the liner and the screws and close the lid. Return unused items to "Cable and Manual Storage."

Fig. 4. Cable and Manual Storage Compartment.

Fig. 5. Removing liner screws

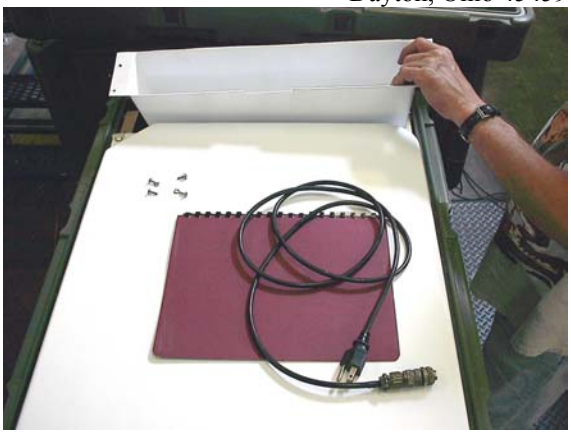

Fig. 6. Lifting out liner

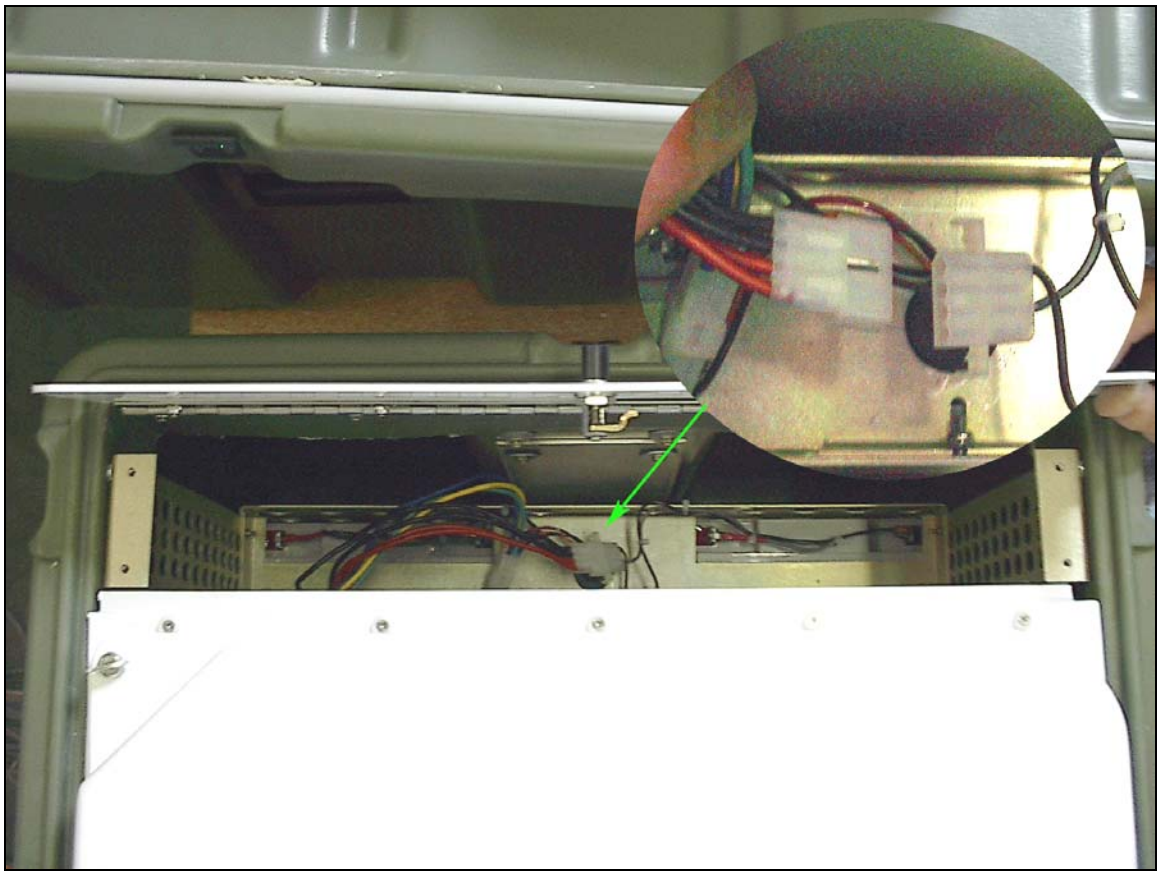

Fig. 7. Battery connector

Control and Power Panel:

Prior to starting the unit, become familiar with the control and power panel. The panel is located on the electronics compartment end of the machine (see right side of **Fig. 1,** page 4). It has two power input connectors (numbers **2** and **3** in **Fig. 8**).

The smaller connector (**2**) is for the AC power cord that arrives with the unit, stored inside the Cable and Storage Compartment. The two fuses, **5a** and **5b** (see Appendix C, Tools and Parts), are in line with this connector internally.

The larger connector (**3**) is either for a solar panel array or for employing one of the optional power adapter cables used to run the unit from either 12 VDC or 24 VDC external power.

Choose which external power source you intend to use during startup. Be certain the necessary cables are available. The most common choice is to use the AC power cord that comes with the machine.

Fig. 8. The control and power panel.

C. STARTING THE HemaCool™ :

CAUTION: Do not turn on the HemaCool™ until you have read the entire user's manual. Failure to understand the meaning of the LED readouts could result in loss of stored blood, blood products, or medical supplies and possibly do damage to the unit.

Fig. 9. HemaCool™ Display

1. **Select the temperature** you want to operate the unit with the toggle switch on the power panel (**Fig. 8** number **1**).

   The COOL (+4.0) control point is ONLY used for storing materials that must be stored above freezing. The FREEZE (-22° C) control point is ONLY used for materials to be stored frozen. (If the ambient temperature is more than +30°C [+86°F], the device may not have the capacity to hold the payload at FREEZE temperature below -20°C [-4°F]. See specifications at the end of this document.)

CAUTION: Selecting the wrong set point for your materials can damage or destroy them. It is the end user's responsibility to choose the control set point that matches the temperature requirements of the payload. If in doubt, contact the manufacturer of the materials to be stored for the temperature requirements so that the correct control set point is selected. **The set point selected is indicated on the LCD readout -- COOL or FREEZE -- by the letters "c" or "f", respectively, at the right end of the upper line of the display (**see **HemaCool™** Display and Alarm Functions, below).

2. **Pull out on the switch bat (handle)** and flip it **up** for **4.0°C** (39°F) control setting, and **down** for **–22°C** (-7°F) operation **(Fig. 8**, number **1).**

3. **Attach the external source** of power selected for the unit's initial 24-hour cool-down and stabilization period (connectors at **Fig. 8,** numbers **2** and **3)**. Plug the power source into the control and power panel (**Fig. 8**) on the electronics end of the unit (right side **Fig. 1**).

CAUTION: Only AC power (and optional solar power) inputs charge the batteries. **Though engaged to the same connector as solar power, 12 VDC and 24 VDC auxiliary power is applied through an isolated pin and does not charge the batteries**. It can, however, be used to assume the load of the 24-hour stabilizing period.

4. **Press the ON/OFF button** (**Fig. 8** number **4**). When operated from AC power, the unit's indicator lamps above and below the temperature selector (**Fig. 8** number **1)** will illuminate to show the unit is operating and at which temperature setting. If you are operating on battery power, only the display panel lights will come on. This is how you can be sure your AC power is connected and switched on. Be sure the correct setting for your payload is indicated. The unit will now run, and the bottom line of the display (**Fig. 9**) will read "STABILIZING 24hr".

Stabilization:

CAUTION: The HemaCool™ must be started and allowed to operate for a 24-hour stabilizing period before payload is put in place. This stabilizing period ensures that the unit's batteries are fully charged. Battery charge level is shown on the display (see Display and Alarm Functions, below). Never begin a portable mission if the battery voltage is below 14.2 volts.

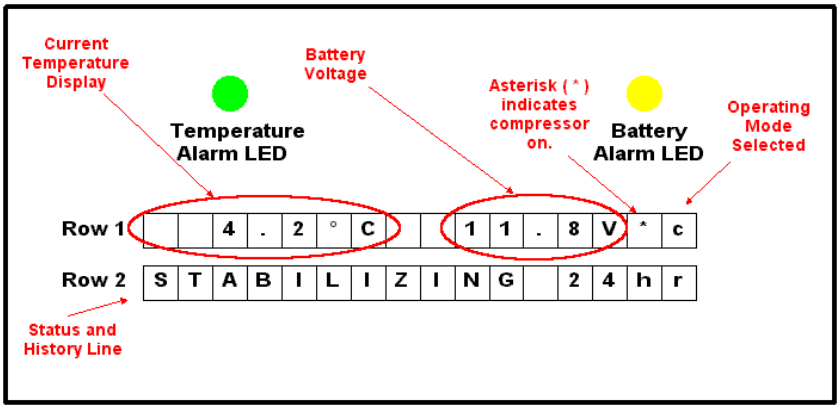
Current Temperature Display
Battery Voltage
Asterisk (*) indicates compressor on.
Operating Mode Selected
Temperature Alarm LED
Battery Alarm LED
Row 1
4 . 2 ° C
1 1 . 8 V * c
Row 2
S T A B I L I Z I N G 2 4 h r
Status and History Line

Fig. 10. Diagram of display during 24 hr. stabilization period.

The temperature within the **HemaCool™** will reach satisfactory levels for storing the payload well before the twenty-four hour stabilizing period ends. However, the unit will not achieve peak energy efficiency until 24 hours of continuous operation has been completed.

During stabilization, the unit's power demand will be above average. Therefore, it is recommended that charging be done with an external power source during the first 24 hours, and any time batteries require charging.

Once this stabilization time is completed, the unit may be disconnected from the cabled power source. It is then portable and under internal battery operation. If the unit is

disconnected long enough for the payload space to reach ambient temperature the stabilization period must be repeated.

Following the 24-hour stabilization, the bottom row of the LCD display will display a high/low temperature history. These alternate at 10-second intervals between the maximum and minimum temperatures that have occurred in the most recent 7-day period. This display reports how many days previously the maximum and minimum temperature occurred (to the nearest ½ day). The maximum length of the stored history is one week, after which the data is purged and the record begins again. The schematic on page 12 shows how the information is displayed for the stabilization period (Fig. 10).

Solar Option:
If solar power is the only available power source, it is recommended the solar panel be allowed to charge the batteries for at least four (4) days before pressing the ON/OFF switch (**Fig. 8** number **4**) to start the unit.

Change of Mode:
The temperature control point may be changed during operation. This is done by re-setting the toggle switch (**Fig. 8** number **1**). Care must be taken, however, not to damage stored blood or blood products. If the temperature is changed during operation, the **HemaCool™** must be allowed to equilibrate to the new temperature set point before it is used to store or transport materials at the new temperature.

D. HemaCool™ DISPLAY AND ALARM FUNCTIONS:

Information on the status of the **HemaCool™** is presented on a display panel (**Fig. 10**), which employs two light emitting diodes [LED] and a liquid crystal display (LCD) that includes two rows of text.

LEDs:

Two multicolored LED indicators provide temperature and battery status alarms. The temperature LED – on the left – shows GREEN when the temperature is in the selected range and RED when it is outside that range. In COOL mode it will also turn YELLOW when the unit is switching between compressor and heater operation. This happens if the ambient temperature has crossed over to the other side of the control temperature. The battery status LED – on the right – shows GREEN when the battery has 10% or more of charge, YELLOW when it has less than 10% of charge, and RED when the charge is nearly gone. (When the unit is operated on AC power, the battery status [right LED] should always illuminate GREEN or change to GREEN within a few minutes as the internal battery recharges).

The tables below show the exact temperatures and voltages that trigger the LED color changes for different set points:

Temperature LED Indictors: Temperatures for COOL mode

LED COLOR	PAYLOAD SPACE TEMPERATURE
GREEN	Between 1.0°C and 6.0°C (Between 34°F and 43°F)
YELLOW	Unit is transitioning from compressor to heater operation or vice versa.
RED	1°C and Below (34°F and Below)

Temperature LED Indicators: Temperatures for FREEZE mode

LED COLOR	PAYLOAD SPACE TEMPERATURE
GREEN	Below –20°C (Below -4°F)
RED	-20°C and Above (-4°F and Above)

Battery Voltage LED Indicators:

LED COLOR	BATTERY VOLTAGE
GREEN	11.8V and Above
YELLOW	Between 11.5V and 11.8V
RED	11.5V and Below

Audible Alarm:

HemaCool™ mil version has an audible alarm that sounds *only* when the unit is operating on AC power and a RED alarm condition occurs – that is, when temperature or battery voltage is outside its nominal operating range. The alarm sounds three times at one-second intervals in a cycle that recurs every eighteen seconds. *The alarm indicates that the payload is in danger and immediate attention is required.* Typically, this means attaching a different applicable/available power source to maintain unit operation while simultaneously charging its internal batteries.

LCD Display:

The LCD display includes two rows of text. Reading from left to right, the top row shows:

- Payload temperature -- from -30.0°C to +50.0°C (from -22°F to 122°F)
- Operating voltage

- Compressor or heater status – whether the compressor or heater is operating

And:

- If the compressor is operating an asterisk appears immediately following the voltage readout.
- If the heater is operating, a lower case "h" appears immediately following the voltage readout. [Regardless of ambient temperature, the heater never operates if the unit is being used as a freezer.]
- The last character in the top row will be either a "c" to indicate COOL mode (4.0°C [39°F] setting) or an "f" to indicate FREEZE mode (-22°C [-7°F]) setting).

Reading from left to right, the bottom row of text alternates each 10 seconds between:

- The Minimum or Maximum temperature measured in the payload compartment within the past week
- How long ago (in days) since that temperature was last measured.

And:

- During the first 24 hours of operation, the bottom row of the LCD display will read "STABILIZING 24hr" to indicate that the **HemaCool™** has not achieved full operating stabilization.

E. DATA LOGGER AND POCKET PC DOWNLOAD:

The unit is equipped with a data logging system. This system monitors the payload temperature, the ambient temperature, and the HemaCool™ main battery voltage. The data log may be downloaded by IrDA link into a Pocket PC (PPC) computer employing the Windows CE operating system. This produces a text file that may be imported into a spreadsheet program for graphing. The data logging system records a data point every five minutes for up to 37 days. The logger is powered by a AA size lithium battery with an operating life expectancy of 10 years.

Preparing Your Pocket PC

Use ActiveSync to place a copy of HemaLog.exe in the **\Windows\Start Menu** folder of the PPC. This is accomplished by opening ActiveSync with the PPC in its cradle, clicking down to the Start menu, opening that, then dragging HemaLog.exe into it from the HemaLog™ Software CD.

After you start the HemaLog™ program on your PPC you will see:

The main screen:

Center: **HemaLog Data Acquisition Tool**

Bottom: Two menus, **Access** and **Display**.

Access menu includes:

Initialize/start collection	- sets up the logger and starts data collection (also needed after battery change).
Check battery condition	- reports percent battery is charged.
Download data	- brings logged data into PPC.
Download and re-start	- brings logged data into PPC, **clears logger memory** and resumes data collection.

Display menu includes:

List data	- shows time and temperature data in tabular form.
Graph data	- shows data vs. time in graphic form (some versions require a separate graphing program).
About	- shows company logo, copyright, name, and contact information.

Each menu item has its own page and a plain text explanation, a start button and a message window (except **About**), and an OK button to return to the main page.

The downloaded data files are ordinary text files suitable for import into Excel after they have been copied into a PC using ActivSync. Each file is named using its logger's ID number with ".txt" appended. They are stored in a directory called \HemaLog on the PPC. If you make a second download from the same unit into your PPC without first deleting the old download file, the new data, including a new header, will be appended to the end of the old file. This is to prevent accidental deletion of data. However, to graph this appended data in Excel or other spreadsheet program, you will need to separate the new data by scrolling down to its header, then selecting and copying it into a new worksheet. To avoid lengthy data files, it is recommended you import the files to a PC for permanent record keeping, then delete them from the PPC

Accessing the data logger memory:

Use your PPC stylus to depress the red button labeled "Data Port" on the display panel (**Fig. 9, page 10**). This stops data logging and readies the logger for IR port communication. Wait five seconds, then align the IR port of your PPC with the IR window in the lower right corner of the display (**Fig. 11**), and then select the Access menu. From there, select one of the two download functions in the submenu. **Download and re-start** is most often used, as it retrieves the data and clears the logger memory for

new data. **Download and stop** downloads data, but leaves the collected data in the logger's memory. The message window at the bottom shows the data block count incrementing during download.

You must use the **Initialize/start collection** function to start collecting data after the **Download data** function has been used. The **Download and re-start** function does both of these things in one step. After accumulating data for 37 days, the logger's memory will be full. If this happens, the logger continues collecting data by overwriting the oldest data with new data points.

Once data has been retrieved, the software organizes it into a text file. This file is placed in the \HemaLog folder in the PPC. Be certain to note the logger unit ID Number for your refrigerator when you download and save data. This number is **not** the same as the unit serial number. The two are kept different to prevent confusion if a repaired HemaCool™ gets a different logger. From left to right, the columns of data in this file show:

Time
Payload Temperature
Ambient Temperature
HemaCool™ battery voltage

A new row with all this information is added for each five-minute data collection event during the logger's operating period. This file may be transferred to your PC by the ActiveSync program for later use.

Viewing Data

After retrieving data, press the OK button to return to the main screen. From there, select the Display menu to view the data. Select the **List data** function to see the data in tabular

form, and **Graph data** function to display a graph. (Note: some versions require you to open the data file in a separate graphing program).

Additional instructional details for this software are in the 'Help' files that come with HemaLog™ software and which may be read on your computer.

Fig. 11. PPC IrDA port data collection.

F. HemaCool™ MAINTENANCE :

WARNING:

[1] Disconnect all external power sources before connecting or disconnecting batteries.

[2] Disconnect all external power sources before performing maintenance or before removing the cover over the electronic section of the unit.
FAILURE TO COMPLY MAY RESULT IN INJURY OR DEATH TO PERSONNEL.

10 Standards — Operator maintenance			
TASK	**PASS**	**FAIL**	**FAIL ACTION**
Check line fuses if unit blower does not run constantly when operating on AC power.			Replace Fuses (see below).
Check intake filter for dirt accumulation daily.			Clean (see below).
Check lid gasket for cleanliness and debris weekly or when water accumulates inside.			Clean; remove debris (see below).
Check lid gasket for cuts or tears weekly or when water accumulates inside.			Initiate repair WO.
Check bottom of inside tub for water accumulation daily in high humidity, weekly in dry conditions.			Remove water (see below)
Check battery terminals for corrosion.			Initiate a repair WO.
Keep batteries charged; read 14-14.5V on display daily.			Plug into AC power or solar array to recharge at next opportunity. If batteries don't charge, initiate a repair WO
Make general check for missing or damaged or corroded parts.			Initiate a repair WO

Change Fuses:

The AC power fuses are located adjacent to the AC power input connector (see **Fig. 8**, page 9, numbers **5a** and **5b**). To remove one, press inward on the fuse holder cap and

turn it ¼ turn counterclockwise and pull it straight out. Insert a new fuse (Appendix B, item 100523) and reverse the procedure. There are also internal fuses, but we recommend a qualified technician change these should it be necessary (see Service and Repair manual).

Clean Filters:

To clean the dust filters or the condenser coil, open the Electronics Compartment lid (**Fig. 3,** page 6), right side. The filters are removed by thumbscrews inside the compartment and may be washed in water. See **Fig. 12** below. Filters should be checked once a month in normal indoor conditions, more often in dusty environments, and after every excursion.

Fig. 12a. Filter location

Fig. 12b. Removing filter

Fig. 12c. Remove and wash filter screens

Check Lid Gasket:

When the lid gasket is in good working order, there should be little or no accumulated moisture found inside the **HemaCool™** unless the lid is opened and closed frequently. If a lot of moisture seems to be accumulating while the lid is kept closed, it may be that the lid gasket is dirty, is closing on debris, or has gotten cut or damaged. To inspect the seal, open the lid and look for dirt and debris accumulation on the black rubber gasket and along its edges. Also check for dirt and debris along the gasket's mating surface inside the unit, and clean the unit using a damp sponge if needed (**Fig. 13** and **14**). Cleaning with a damp sponge may be done quickly, so you don't have to remove the payload to another refrigerator while you do it.

Mild cleanser such as Soft Scrub™ may be used to assist in cleaning, but must be rinsed away carefully afterward. Cleaning with soap, then rinsing, requires you to move the payload to another storage refrigerator during cleaning. This is to protect the payload both from heat and from contamination.

If it should become necessary, the plastic parts of the HemaCool™ may also be wiped with a 10% solution of chlorine bleach. The unit's payload, if salvageable, must be moved to another refrigerator while this is done. The bleach must be rinsed away and the unit allowed to dry before placing it back in service.

If cuts or tears in the seal are found, refer the unit to a qualified technician for replacement (see Service and Repair Manual).

Fig. 13. Inspecting lid gasket

Fig. 14. Inspecting gasket mating surface.

Check For Moisture Accumulation

If the unit's seal is compromised (see above), or if it is opened and closed frequently in a humid environment, moisture will accumulate in the bottom of the tub. This moisture may be removed using a sponge or absorbent towels. If you get a lot of water, you may use a wet-dry shop vacuum cleaner or a water aspirator connected to running water to suction it away.

Check For Battery Terminal Corrosion

If the unit is in a humid or hot environment, check for battery terminal corrosion once a month. It the unit has symptoms of poor battery performance (short run-time on batteries), check for battery terminal corrosion.

To check for battery terminal corrosion, open the unit's Cable and Manual Storage compartment lid (**Fig. 4,** page 7) and use a # 2 Philips head screwdriver to remove the compartment liner (**Fig. 5** and **6,** page 8). Looking down into the box, the battery terminals are visible (see **Fig. 15**).

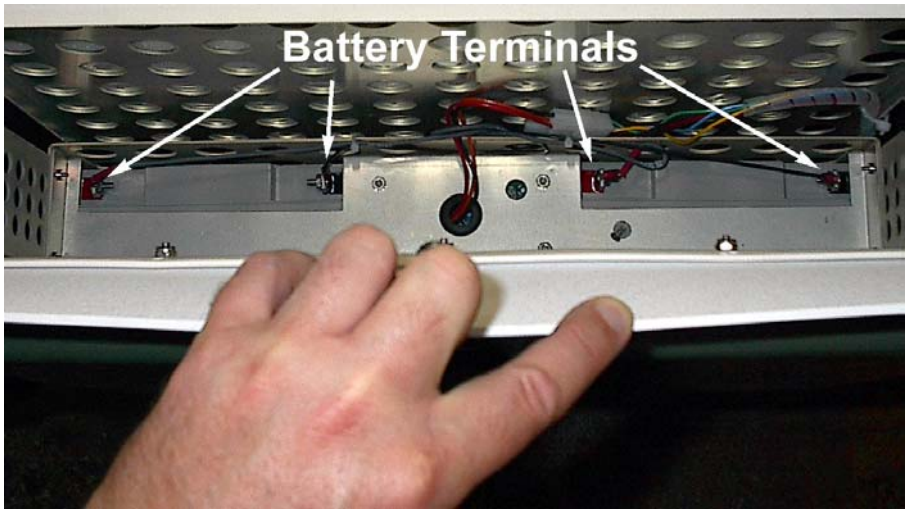

Fig. 15 Battery terminal locations

Keep Batteries Charged

The gel cell batteries in this unit require a full charge to maintain their full capacity. Allowing a discharged battery to sit without recharging begins to deteriorate its capacity to hold a new charge in as little as a few hours. When the unit is plugged into AC power or into a solar panel array, its batteries will charge. **Connecting auxiliary power or an external battery to the unit does not recharge the unit's internal batteries.** Batteries that are fully discharged may require as much as 24 hours to fully recharge on AC power, and as much as four days on a solar array with good light conditions. After allowing time to recharge the batteries, you should see 14—14.5 VDC on the unit's display (**Fig. 9** and

10, page 10 and 12). If this voltage does not appear or if the batteries run down quickly, initiate a repair WO.

20 Standards — Maintainer Checks and Verifications			
TASK	PASS	FAIL	FAIL ACTION
Temperature Regulation Test: **ONLY PERFORM THIS TASK WITH DUMMY PAYLOAD. REAL PAYLOAD WILL BE DAMAGED.** Insert temperature probe and test both operating temperatures, allowing 24 hour stabilization after each setting change.			Check that unit power source is correct, or, if on batteries, that they have charge. If still failing, initiate repair WO for control circuitry.
Test that side display numbers match measured internal temp +/– 1°C.			Initiate repair WO for control circuit.
Check that both side display indicator lamps illuminate.			Initiate replacement WO for display circuit board.
Check that both temperature setting indicator lamps on the power panel illuminate.			Replace power panel module and initiate repair WO for old panel.
Check continuity on all power cords. Test for shorts between connectors. Any repaired cord must be re-tested for correct pin polarity. All ground wires shall not have more than 0.1 ohm resistance pin-to-pin.			Initiate repair WO for failing cord.

20 Standards Task Details

Temperature Regulation and Display Tracking Test

This test requires placing a calibrated temperature probe into a dummy payload and measuring the actual payload temperature being maintained by the unit. The temperature probe may be a calibrated thermocouple for a calibrated thermocouple thermometer. It may also be a temperature-logging device, such as a Sensitech Temptale™ that has been calibrated. The dummy payload may be commercial cold packs such as "Kool-Its™" or "Blue Ice™" or blood bags filled with 30% calcium chloride solution to which 1/8 teaspoon or 0.5 cc of blue food coloring has been added to distinguish the solution from real blood products. The dummy load must also be **clearly** labeled with its contents, and in large letters: **NOT FOR MEDICAL USE**.

These tests must not be conducted with a real payload. Real payloads of blood products require particular temperature ranges. When you switch control points during this test, the temperature will temporarily go outside safe ranges for any blood products.

In a room temperature environment, arrange the dummy load in the **HemaCool™** blood baskets. Place the temperature sensor in the middle of the payload and in intimate contact with the payload. Set the **HemaCool™** to the **4°C** set point and turn it on. Note procedures for setting temperature with the "locking toggle" switch, page 9. Allow it to stabilize with the dummy load for at least 24 hours. After 24 hours of stabilization, if you are using a thermocouple thermometer, measure the temperature. It should be between **2°C** and **5°C** ± the accuracy tolerance of your thermometer. The displayed temperature should agree within **1°C** and should not be outside the range of **2°C** and **5°C**. If you are using a data-logging device, it should be set to log data points every 5 minutes. The logging device should be placed in the unit at the beginning of the 24 hours

stabilization period. The last temperature logged before you removed the logger from the unit should be between 2°C and 5°C as with the thermocouple measurement.

Pull out on the front panel toggle switch and change the temperature setting to **–22°C**. After allowing 24 hours for the unit to stabilize, check that your thermometer reads at least **–22°C** ± the accuracy tolerance of your thermometer. The display on the side of the unit should agree within **2°C** at this temperature.

Check Indicator Lamps

To test the temperature indicator lamps on the side display, after the unit has been stabilized at the **4°C** setting, observe that the temperature indicator lamp is GREEN, open the lid and remove the dummy load baskets nearest the display end of the unit. In the middle of the tub wall at that end you will see the black temperature sensors protruding slightly. Place your hand over these until the display shows **6°C** or higher. The temperature indicator lamp should turn from GREEN to RED within 20 seconds of the temperature change.

The battery indicator lamps may be tested by disconnecting the unit from external power and allowing the battery to run down. You may observe the battery voltage on the display. As the battery runs down, the display should change color at the voltages indicated in the tables on page 15. **CAUTION, this test will run the battery down and allow the unit to stop. Never conduct this test with real payload in place or it may be ruined.**

To test the temperature setting indicators on the power panel, observe that the lamp is correctly lit for your current setting. Pull out on the temperature setting toggle switch and change the setting. You should see the first lamp go out and the second come on. Immediately return the switch to your original setting to avoid affecting the inside temperature.

All indicator lamps on this unit are LEDs soldered in place and have no operator changeable bulbs. They must be replaced by a qualified technician, so a repair WO must be initiated to replace them.

Other Repair and Maintenance:

Refer to the HemaCool Service and Repair Manual.

G. HemaCool™ SPECFICATIONS:

Model HMC-1-MIL

- Internal Temperature regulation:
  - COOL mode: 4.0±1.5°C (39°F ±2.7 °F)
  - FREEZE mode: –22C° +0/–6°C (–7°F +0/–11°F) in 30°C (86°F) ambient or lower temperature
- Weight:
  - Empty with batteries: 135 lbs (61 kgs.)
  - Fully loaded: 175 lbs (79 kgs.)
- Estimated Power Consumption during COOL mode chilling: <40W at room temperature (55W at 40°C ambient [104 °F])
- Estimated Power Consumption for COOL mode storage only: <20W at 40°C ambient (104°F)
- Payload Capacity:
  - Storage + Chilling
    - 24 x 450ml units plus
    - 5 x 450ml fresh blood
    - Thermal Barrier in place
  - Storage Only (2 additional baskets in place of Thermal Barrier): 40 x 450ml units or 60 x 250ml units
- Exterior dimensions: 23”H x 19.3”W x 37”L (58.4 x 49 x 94cm)
- Interior dimensions: 13”H x 14”W x 18”L (33 x 35.6 x 45.7cm)
- Gel Cell Batteries:
  - 12 volt, 40 Amp-hour total capacity
    - Set contains 2 x 20 Amp-hour batteries
    - Battery Weight (total): 34 lbs (15.4 kgs)
    - Provides 24 hours of operation in storage only (no chilling of warm material) mode

- Accommodates a variety of power sources:
    - solar array (together with batteries)
    - AC power from grid or generator,
    - Batteries or external 12—28 VDC to auxiliary input.
    - Grid power required: any combination of 85—264 VAC and 47—63 Hz.
- Employs 50 gm, environmentally safe R 134A refrigerant.

H. WARRANTY:

The **HemaCool™** is warranted to be free from defects in manufacturing and workmanship for a period of one (1) year from the date of purchase. Customer abuse is not covered by this warranty. This limited warranty covers repair or replacement of the unit at EST's discretion. In no event shall EST be liable for any indirect, special, consequential or incidental damages, including but not limited to, damages for loss of use of equipment, loss of revenue, loss of product, loss of profits or loss of goodwill, regardless of whether EST (a) has been informed of the possibility of such damages or (b) is negligent. If the unit fails during the warranty period, it must be shipped to EST or the factory-designated service center for repair or replacement. The unit must be packaged such that it will not be damaged in transit and insured for its full value. Should the failure be attributed to customer abuse, EST will charge the customer for the repair costs.

Appendix A

PCM Wall Option

The **HemaCool™** has -- optionally available -- a thermal barrier that isolates already cooled payload from newly added warmer payload. This barrier is a plastic shell surrounding a phase change material (PCM), and is called a PCM wall. The PCM inside the wall is specially formulated to freeze and thaw at 6°C (43°F), which is the upper temperature limit of the **HemaCool™** 4°C (39°F) cooling mode. As a result, it gradually freezes when the **HemaCool™** is operating normally, then thaws whenever any payload warmer than 6°C (43°F) is placed next to it, thereby absorbing heat from that object. Placed between payload warmer than 6°C (43°F) and payload already cooled below 6°C (43°F), it mitigates heat flow from the warmer to the cooler payload.

In use, the PCM wall replaces two baskets in the payload area, dropping down into their basket flutes in the sides of the payload area liner. A warm PCM wall should never be placed in an already chilled payload. Instead, the PCM wall should be put in place in an empty **HemaCool™** and chilled 24 hours before payload is added. Alternately, the PCM wall may be chilled for 24 hours in a conventional refrigerator prior to use.

It is suggested that the user with multiple units decide in advance which unit will require a PCM wall, then install the wall and let it cool with the rest of the unit when first turned on.

Fig. 16. PCM Wall

Appendix B

Tools and Parts

The following items are replaceable by the operator. They are inspected in the normal maintenance cycle or upon detecting a failure of some kind, and may be replaced by the operator.

Tools and Supplies

Item	EST Part Number	OEM Part Number
# 2 Philips Head Screwdriver	100631	
Calibrated thermometer or temperature logger	100632 100634	Omega Eng., Inc. HH21 SensiTech TempTale 3 #T2100-01
Cellulose sponge for moisture removal and cleaning the lid gasket		

Replacement Parts and Accessories

Item	EST Part number	OEM part number
Line fuses, F03A 250V 3A type	100523	Littlefuse 0312003.H
AC Power Cord (U.S.)	100002	EST assembly
AC Power Cord (Europe)	100626	EST assembly
AC Power Cord (Britain)	100627	EST assembly
AC Power Cord (Australia)	100628	EST assembly
HMVV Battery cable	100003	EST assembly
Intake Filter Screens	100249	EST modified
Blood Bag Baskets	100000	EST produced
Operation and Maintenance Manual on CD	100005	EST produced
Service and Repair Manual on CD	100624	EST produced
Data Logger Pocket PC Software CD	100625	EST produced